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# 1536™

# IEEE Standard for Rail Transit Vehicle Battery Physical Interface

## IEEE Vehicular Technology Society

Sponsored by the
Rail Transit Vehicle Interface Standards Committee

IEEE

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# IEEE Standard for Rail Transit Vehicle Battery Physical Interface

Sponsor

**Rail Transit Vehicle Interface Standards Committee**
**of the**
**IEEE Vehicular Technology Society**

Approved 10 December 2002

**IEEE-SA Standards Board**

**Abstract:** The maximum dimensional requirements of each battery tray for a specific number of cells and battery capacity or performance rating are prescribed in this standard.
**Keywords:** battery tray, high discharge rate, low discharge rate, medium discharge rate, multi-cell unit

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# Introduction

(This introduction is not part of IEEE Std 1536-2002, IEEE Standard for Rail Transit Vehicle Battery Physical Interface.)

It is the intent of this standard to establish a limited number of agreed-upon standardized battery tray sizes for each of two types of case material, polymeric and steel.

The user is advised that the use of this standard may increase the space required for the battery tray. This impact should be evaluated if the space is at a premium on the vehicle.

This standard defines the maximum physical size and weight of nickel-cadmium (Ni-Cad) battery trays for both polymeric and steel cells. The cells in the tray are made of polymeric or steel containers. The maximum dimensional envelopes listed are for two to six cells and for capacities from 80 Ah to 240 Ah of "M" medium and "H" (high) rate of discharge performance batteries as defined in IEC-60623. Other battery technologies or "L" (low) or "X" (very high) rate of discharge Ni-Cad batteries are not covered in this standard.

This standard also addresses the battery compartment dimensional requirements to contain the battery tray envelopes.

Since Ni-Cad batteries are manufactured with different plate technologies with different efficiencies even though they may have the same capacities and same rate of discharge performance, the actual derating factors used for sizing batteries such as state of charge, temperature, etc. could vary. Therefore, the battery load profile is provided to the battery manufacturer. The load profile is developed in accordance with 4.4.2 of IEEE Std 1476™-2000. The authority maintains and updates the load profile information. It is the authority's responsibility to check that the existing battery continues to satisfy electrical requirements as the load profile changes. The updated load profile should be readily available for the future procurement/replacement of the battery of the vehicle/consist.

The Ni-Cad battery is electrically sized according to IEEE P1568™.[a]

The authority maintains a record of the computations used to select the size and the rating, since the same load profile can produce a number of battery choices with different ampere-hours and ratings. In order to maintain interchangeability, it is important to keep the size, selection method, and parameters available for future procurement/replacement of the battery. Should this information not be available, the authority will need to develop a new load profile. The authority may allow the replacement of an existing battery that meets the load profile with a physically different battery. It is the responsibility of the battery manufacturer to submit the information needed for proper installation.

## Participants

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| | | |
|---|---|---|
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[a]Information on references can be found in Clause 2

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# IEEE Standard for Rail Transit Vehicle Battery Physical Interface

## 1. Overview

This standard applies to new procurements or major rehabilitation of rail transit vehicles occurring on or after the effective date of this standard. Existing rail transit vehicles and those vehicles currently being procured need not comply except when specifically required by the authority having jurisdiction. Where a need exists to maintain compatibility with existing rail transit vehicles, those portions of this standard in conflict with compatibility requirements need not be applied.

### 1.1 Scope

This standard prescribes the maximum dimensional requirements of each battery tray for a specific number of cells and battery capacity or performance rating. The battery hardware requirement and battery compartment are also prescribed in this standard.

### 1.2 Purpose

The purpose of this document is to standardize the physical dimensional requirement of a battery tray. Currently, there are no overall dimensional standards for a battery tray. The same rating batteries are being produced in different cell sizes by different manufacturers to suit customer battery compartment requirements. This standard will provide an optimal battery compartment with interchangeability of batteries supplied by various manufacturers. Thus, it will facilitate joint multiuser purchases.

## 2. References

This standard shall be used in conjunction with the following publications. In case of a conflict between this standard and the referenced document, this standard takes precedence. Those provisions of the referenced documents that are not in conflict with this standard shall apply as referenced.

IEC 60623 (2001-09), Secondary Cells and Batteries Containing Alkaline or Other Non-Acid Electrolytes—Vented Nickel-Cadmium Prismatic Rechargeable Single Cells.[1]

[1]IEC publications are available from the Sales Department of the International Electrotechnical Commission, Case Postale 131, 3, rue de Varembé, CH-1211, Genève 20, Switzerland/Suisse (http://www.iec.ch/). IEC publications are also available in the United States from the Sales Department, American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036, USA.

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IEEE Std 1476™-2000, IEEE Standard for Passenger Train Auxiliary Power Systems Interfaces.[2,3]

IEEE Std 1478™-2001, IEEE Standard for Environmental Conditions for Transit Rail Car Electronic Equipment.

IEEE P1568™ (D2.4), Draft Recommended Practice for Electrical Sizing of Nickel-Cadmium Batteries for Rail Passenger Vehicles.[4]

# 3. Definitions, abbreviations, and acronyms

## 3.1 Definitions

For the purposes of this standard, the following terms and definitions apply. *The Authoritative Dictionary of IEEE Standards Terms,* Seventh Edition [B3][5], should be referenced for terms not defined in this clause.

**3.1.1 battery tray:** The supporting structure that allows two or more individual cells or one or more multi-cell units to be mechanically configured as one assembly.

**3.1.2 high discharge rate (H):** Typically for discharges above 3.5 $C_5$A and up to 7 $C_5$A.

NOTE—The discharge rate is in accordance with IEC 60623 (2001-09).

**3.1.3 low discharge rate (L):** Typically for discharges of up to 0.5 $C_5$A.

NOTE—The discharge rate is in accordance with IEC 60623 (2001-09).

**3.1.4 medium discharge rate (M):** Typically for discharges above 0.5 $C_5$A and up to 3.5 $C_5$A.

NOTE—The discharge rate is in accordance with IEC 60623 (2001-09).

**3.1.5 multi-cell unit:** Two or more battery cells permanently connected.

## 3.2 Abbreviations and acronyms

Ah ampere hours

APTA American Public Transportation Association

IEC International Electrotechnical Commission

IEEE Institute of Electrical and Electronics Engineers

Ni-Cad nickel-cadmium

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[3]IEEE publications are available from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331, USA (http://standards.ieee.org/).

[4]This IEEE standards project was not approved by the IEEE-SA Standards Board at the time this publication went to press. For information about obtaining a draft, contact the IEEE.

[5]The numbers in brackets correspond to those of the bibliography in Annex A.


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## 4. Physical requirements for Ni-Cad batteries

This clause describes the requirements for Ni-Cad batteries.

### 4.1 Cell(s)

The overall cell(s) shall fit within the battery tray envelopes as shown in Table 1 for polymeric cells or Table 2 for steel cells.

**Table 1—The maximum battery tray envelope and weight (wt) for polymeric cells for medium and high discharge rate battery**

| Required capacity [Ah] | W | H | 2-cell tray | | 3-cell tray | | 4-cell tray | | 5-cell tray | | 6-cell tray | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | Wt | L | Wt | L | Wt | L | Wt | L | Wt |
| ≥ 80 to ≤120 | 172 | 353 | 303 | 19 | 419 | 27 | 539 | 36 | 659 | 45 | 779 | 54 |
| > 120 to ≤240 | 211 | 353 | 360 | 31 | 510 | 45 | 670 | 60 | 830 | 75 | 990 | 95 |
| NOTE—Dimensions for width (W), height (H), and length (L) are in mm and wt is in kg. | | | | | | | | | | | | |

**Table 2—The maximum battery tray envelope and weight (wt) for steel cells for medium and high discharge rate battery**

| Required capacity [Ah] | W | H | 2-cell tray | | 3-cell tray | | 4-cell tray | | 5-cell tray | | 6-cell tray | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | Wt | L | Wt | L | Wt | L | Wt | L | Wt |
| ≥ 80 to ≤120 | 192 | 437 | 290 | 25 | 390 | 38 | 490 | 51 | 595 | 64 | 700 | 77 |
| > 120 to ≤200 | 192 | 437 | 370 | 39 | 510 | 59 | 660 | 80 | 810 | 100 | 960 | 130 |
| > 200 to ≤240 | 192 | 437 | 425 | 47 | 590 | 70 | 765 | 95 | 940 | 120 | 1120 | 150 |
| NOTE—Dimensions for width (W), height (H), and length (L) are in mm and wt is in kg. | | | | | | | | | | | | |

### 4.2 Marking

Each cell/multi-cell unit shall be marked as described below:

a) Type of cell.
b) Manufacturer's or supplier's name.
c) The positive terminal of a cell shall be identified by either a red washer or an indented or raised "+" symbol.
d) The negative terminal of a cell shall be identified by either a blue or black washer or an indented or raised "–" symbol.
e) Date manufactured.

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### 4.3 Battery tray envelope

Figure 1 illustrates a 5-cell battery tray.

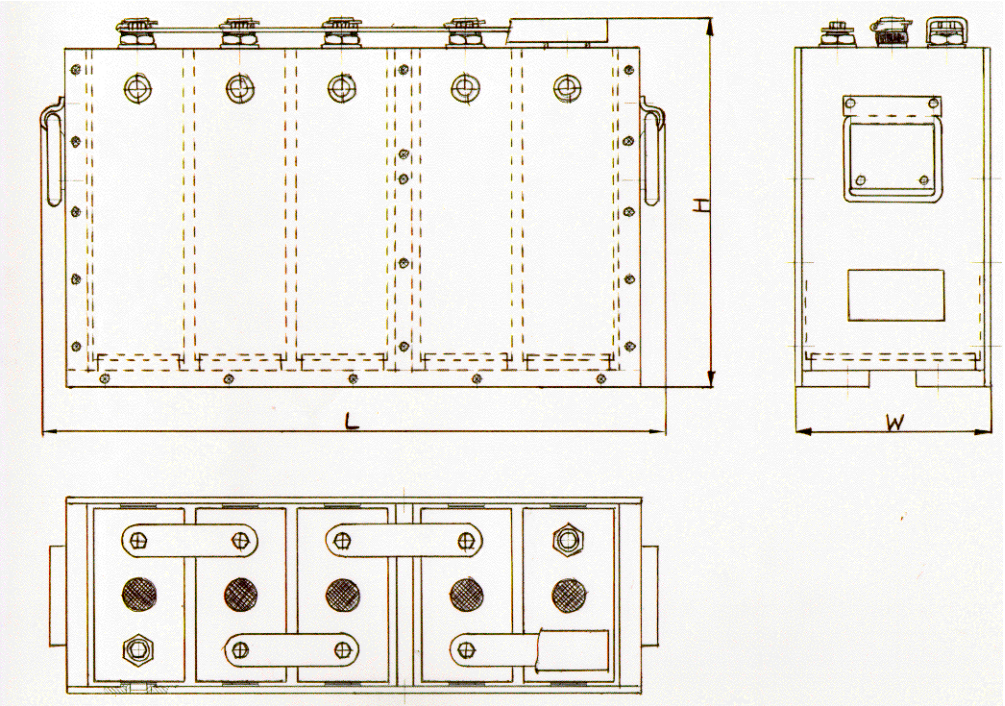



**Figure 1—Illustration of a 5-cell battery tray**

NOTE—The handle type in Figure 1 is for illustration purposes and is not part of this standard. There are other handle types available.

Battery tray weights and envelope dimensions shall be in accordance with Table 1 or Table 2, as applicable. The maximum length shall include the battery tray handles. The maximum height shall be to the highest point of the assembly with vent cap closed. The weight includes cells with electrolyte filled to the maximum level, battery tray, and inter-cell connection but does not include the inter-tray connection and temperature sensors.

#### 4.3.1 Battery tray arrangement

Battery tray arrangement shall be in accordance with Figure 2, Figure 3, Figure 4, Figure 5, and Figure 6.

NOTE—The handle type in Figure 2, Figure 3, Figure 4, Figure 5, and Figure 6 is for illustration purposes only and is not part of this standard. There are other handle types available.


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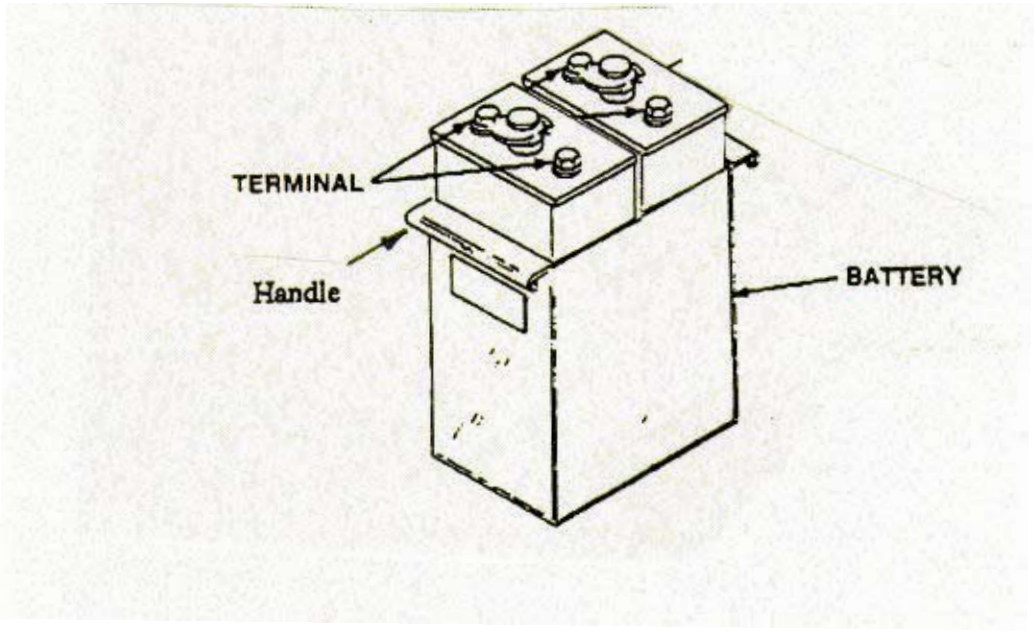



**Figure 2—A 2-cell tray**

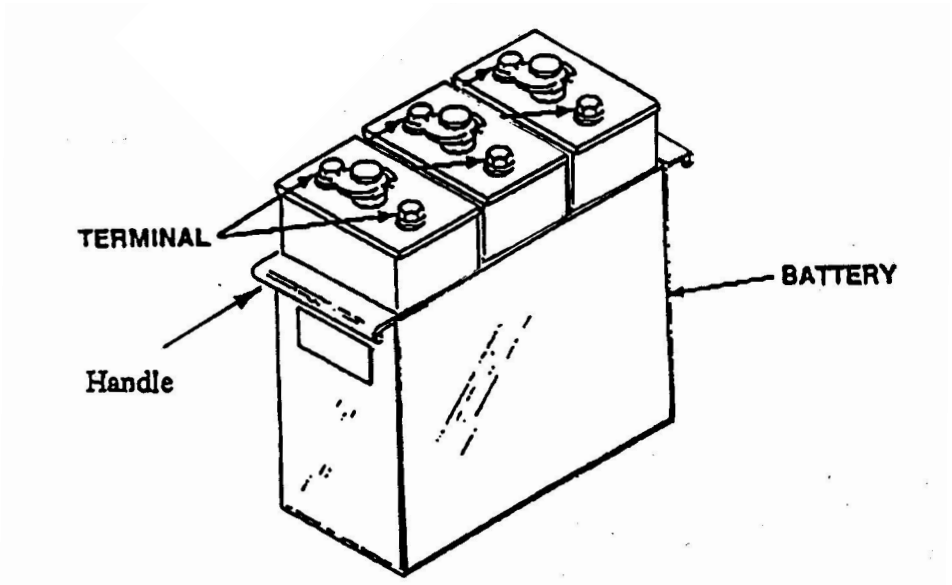



**Figure 3—A 3-cell tray**

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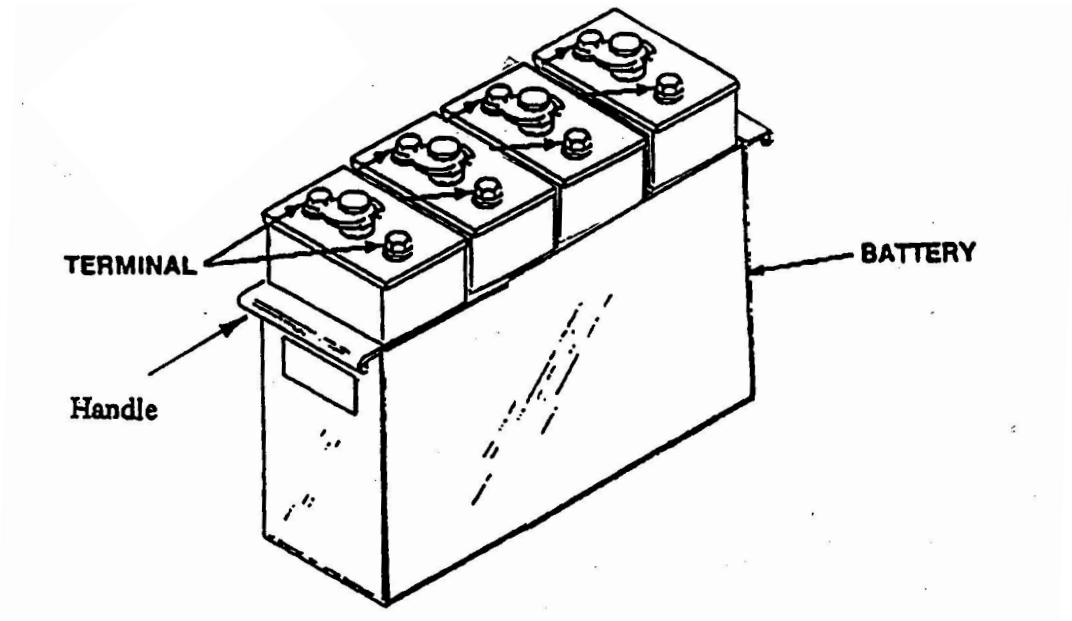



**Figure 4—A 4-cell tray**

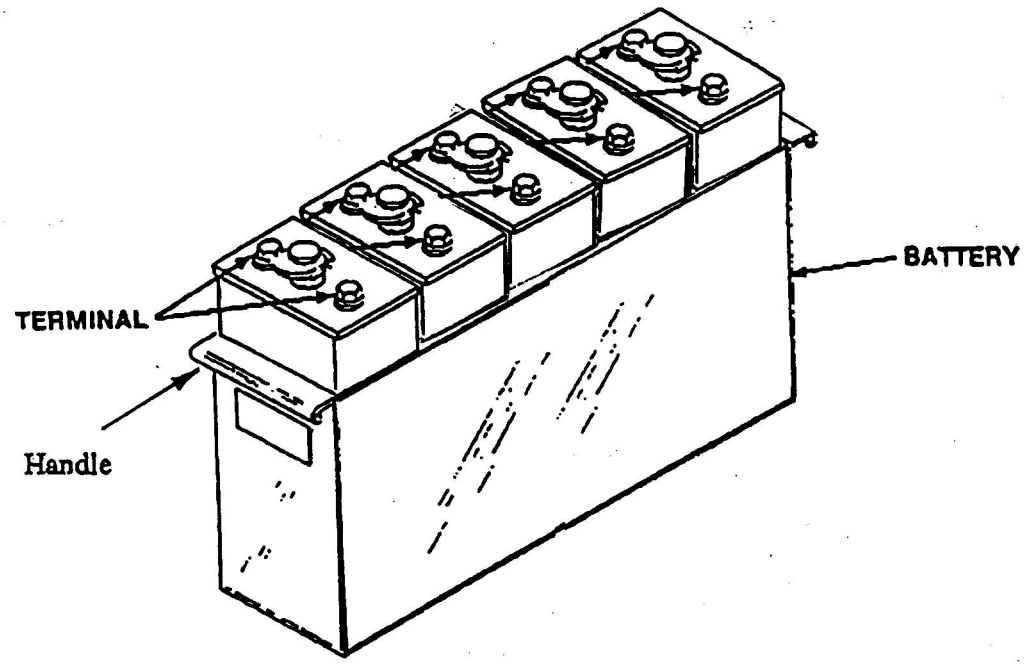



**Figure 5—A 5-cell tray**


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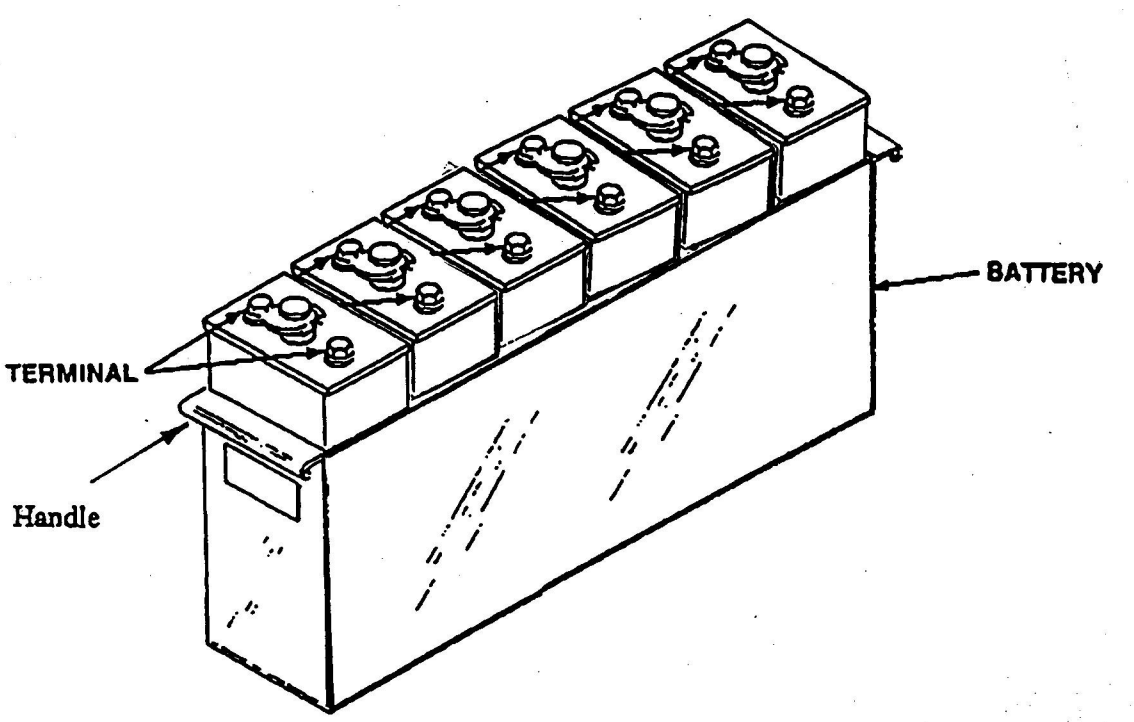



**Figure 6—A 6-cell tray**

### 4.4 Hardware

Acid/alkali-resisting lead covered, stainless steel, or nickel-plated hardware shall be used for battery interface terminals to the vehicle cables. When a replacement battery has a different interface terminal than the existing vehicle cables, it is the responsibility of the battery manufacturer to supply hardware for a proper physical interface connection. This standard covers only the interface hardware from terminals to the vehicle cables.

## 5. Battery compartment

The battery compartment shall be designed to accommodate battery size, weight, and tray arrangements as shown in Table 1 or Table 2 based on case material. The battery compartment shall be designed to withstand the loads and forces specified by 4.1.4 and 4.1.5 of IEEE Std 1478-2001[6] and shall be ventilated to prevent the buildup of dangerous battery gasses.

[6]Information on references can be found in Clause 2.

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# Annex A

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# Bibliography

[B1] APTA RP-E-007-98R1, Recommended Practice for Storage Batteries and Battery Compartments.

[B2] IEC 60077, Rules for Electric Traction Equipment.

[B3] IEEE 100, *The Authoritative Dictionary of IEEE Standards Terms,* Seventh Edition.


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# Annex B

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## How to use this standard

Table 1 and Table 2 provide maximum tray dimension data. These data are based on a compilation of the existing tray dimensions widely used by North American authorities at the time this standard was drafted. This information is provided as a guide to battery manufacturers. These tables can also be used to determine the amount of upgrade available in an existing battery compartment.

First, the load profile of the rail vehicle is established by the car builder in accordance with 4.4.2 of IEEE Std 1476-2000. From the load profile, the battery electrical size is calculated according to IEEE P1568.

A medium discharge rate battery of steel cells is used in the following examples.

*Examples:*

If the required battery is a 90 Ah, 25 steel cells, then the car builder will select the tray dimension from the ≥80 to ≤120 Ah range from Table 2. In this range, the width (W) is 192 mm and the height (H) is 437 mm. For a 2-cell tray, the length (L) will be 290 mm and the weight (wt) will be 25 kg; for a 3-cell tray, the length will be 390 mm and the weight will be 38 kg, and so on. The car builder could arrange the battery cell trays in any combination to make up a 25-cell battery; i.e., five 5-cell trays or five 4-cell trays and one 5-cell tray, or a combination of three 6-cell trays, two 3-cell trays and one cell as shown in Figure B.1, Figure B.2, and Figure B.3. Based on the cell arrangement, the battery compartment would be sized and designed. The battery compartment in Figure B.2 is larger than the one in Figure B.1, but it would allow adding additional cells in the future. The battery compartment in Figure B.3 provides a narrower width than the ones shown in Figure B.1 and Figure B.2, but with capability to add additional cells in the future.

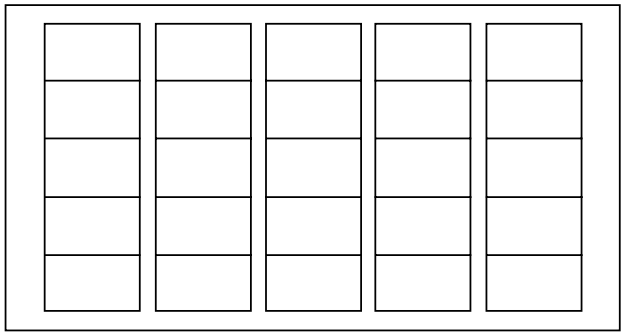


**Figure B.1—Arrangement of five cell trays**

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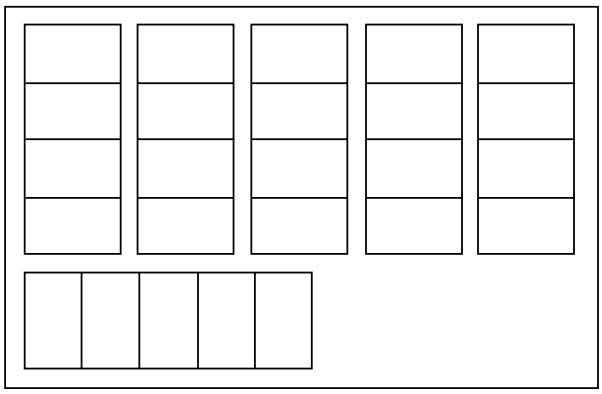


**Figure B.2—Arrangement of five 4-cell trays and one 5-cell tray**

The battery compartment can accommodate up to a 120 Ah high discharge battery even though the required battery is a 90 Ah medium discharge battery. This allows at least 30 Ah (from 90 Ah medium discharge to 120 Ah medium discharge) for future upgrade of the electrical loads without needing to change the battery compartment. A higher discharge rate can be obtained if a 120 Ah high discharge battery is selected.

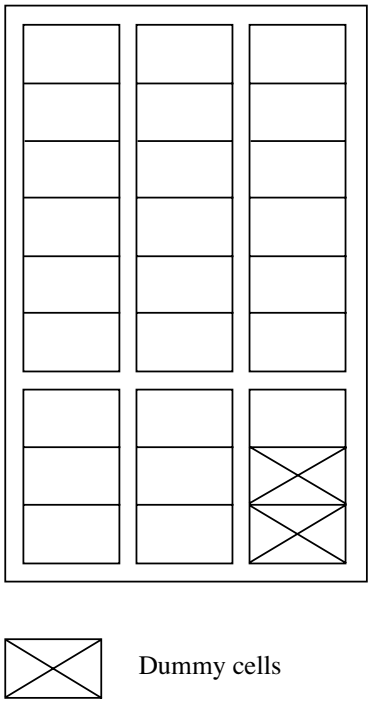



**Figure B.3—Arrangement of three 6-cell trays, three 3-cell trays**


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